of water surcharged with the substance, whence deposits have taken place on whatever nuclei offered, forming a hard radial aggregation, which would continue to grow until either the solution was exhausted or the supersaturation was relieved by external causes. The shape of the concretion must depend on the shape and number of its nuclei and the evenness of concentration in the surrounding solution; in the ideal case of a small single nucleus and a uniform supply of substance from all sides, the concretion becomes an almost perfect sphere, like the manganese nodules met with in certain localities.

Concretions of iron and manganese.

Iron and manganese depend for the formation of supersaturated solutions in bottom-waters on the change of valency of which these elements are capable. Iron is brought into solution as ferrous bicarbonate by the decomposition of minerals; or again a solution of the bicarbonate may be produced locally by the action of decaying organic matter on ferric compounds. Now ferrous oxide is a base of strength comparable to, but rather less than, that of calcium oxide, and is subject to analogous conditions of solubility as bicarbonate. If oxygen were absent, and if the solubility were diminished, *e.g.* by withdrawal of carbonic acid, we should expect a deposition of ferrous monocarbonate (such as has often taken place on a large scale on land). As it is, the ferrous solution, diffusing out of the mud, meets with dissolved oxygen, and the change of valency to ferric iron rapidly supervenes. Ferric oxide, however, is a much weaker base, and the hydrolytic dissociation of its salts with a weak acid like carbonic is so complete as to render a ferric carbonate practically incapable of existence in presence of water. That is, the substance now in solution is ferric hydroxide. But this is a vastly less soluble body than ferrous bicarbonate; therefore the iron in solution is now supersaturated.

Non-manganiferous ferric concretions are comparatively rare, and have been reported only from the North Atlantic and the polar seas,[1] where the terrigenous bottoms are poor in manganese. They attain no great size or hardness, contain much silica, and are rather balls of clay cemented with hydrated ferric oxide.

As for manganese, the manner in which supersaturated solutions come into being is the same, *mutatis mutandis*, as in the case of iron. The deposited peroxide has approximately the composition MnO_2 in deep-sea nodules, but shows notable

[1] Schmelck, Norwegian North Atlantic Expedition, No. IX. p. 52, 1882; Böggild, Norwegian North Polar Expedition, Scientific Results, vol. v. No. XIV. p. 38, 1906.